2018-1-8 واجب EE352 Tutorial

Q1 The maximum flux density in the core of a 250/3000 Volt 50 Hz single phase transformer is 1.2 Wb/m². If the mmf per turn is 8 Volt determine :-

(1) primary and secondary turns (2) area of the core.

(i) $E_1 = N_1 \times emf \Rightarrow N_1 = \frac{250}{8} = 32$, $N_2 = \frac{3000}{8} = 375$.

(ii) $E_2 = 4.44 f_m N_2 B_{max} A \Rightarrow$

$3000 = 4.44 \times 50 \times 375 \times 1.2 A \Rightarrow A = 0.03 m^2$

Q2 The core of a 100 KVA, 11000/550 V, 50 Hz 1ph core type transformer has a cross section of 20cm x 20cm. Find (i) the number of H.V and L.V turns per phase and (ii) the emf per turn if the maximum core density is not to exceed 1.3 Tesla. Assume a stacking factor of 0.9 what will happen if its primary voltage is increased by 10% on no load.

(i) $B_m = 1.3$ T, $\Rightarrow A = (0.2 \times 0.2) \times 0.9 = 0.036 m^2$.

$E_1 = 4.44 f N_1 \Phi_{max} \Rightarrow 11000 = 4.44 \times 50 \times N_1 \times 1.3 \times 0.036$ (BA)

$\therefore \boxed{N_1 = 1060 \text{ turn}}$

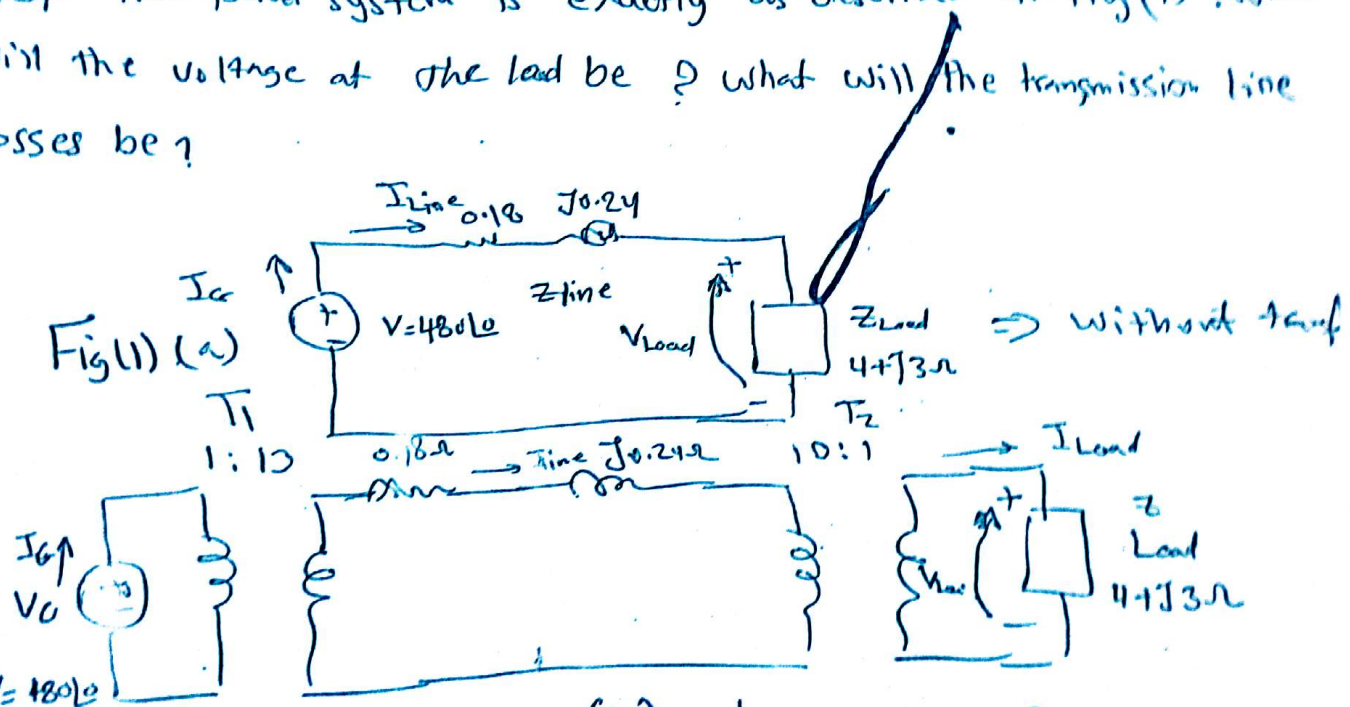
$\boxed{N_2 = K N_1 = \left(\frac{550}{11000}\right) \times 1060 = 53}$

(ii) emf/turn $= \frac{11000}{1060} = 10.4$ Volt or $550/53 = 10.4$ V.

Keeping supply frequency constant, if primary voltage is increased by 10%, magnetising current will increase by much more than 10%. However due to saturation, flux density will increase only marginally and so will the eddy current and Hysterisis losses.

Q3 A single phase power system consists of 480V, 60 Hz generator supplying a load $Z_{Load} = 4+j3\,\Omega$ through a transmission line of impedance $Z_{line} = 0.18+j0.24\,\Omega$. Answer the following questions about this system

(a) If the power system is exactly as described in Fig(1), what will the voltage at the load be? What will the transmission line losses be?



Fig(1) (a) ⇒ without transformers

Fig(1) (b) ⇒ with transformers.

Fig(1) (a) From the power system without transformers Hence

$$I_G = I_{line} = I_{Load} = \frac{V}{Z_{line}+Z_{load}} = \frac{480\angle 0}{(0.18+j0.24)+(4+j3)} = 90.8\ \text{A}$$

The load voltage is

$$V_{Load} = I_{line} Z_{Load}$$

$$V_{Load} = (90.8 \angle -37.8° A)(4+j3) = 454 \angle -0.9 \text{ volt}$$

line losses are

$$P_{losse} = I_{lin}^2 R_{line} = (90.8)^2 (0.18) = 1484 \text{ Watt}$$

(b) Suppose a 1:10 step up transforme is placed at the generator end of transmission line and 10:1 step down transformer is placed at the Load end of the line (Fig (1) b) what will the Load voltage be now? what will the transmission line losses be now.?

The value of the Load's impedance when reflected to the transmiss system's voltage is.

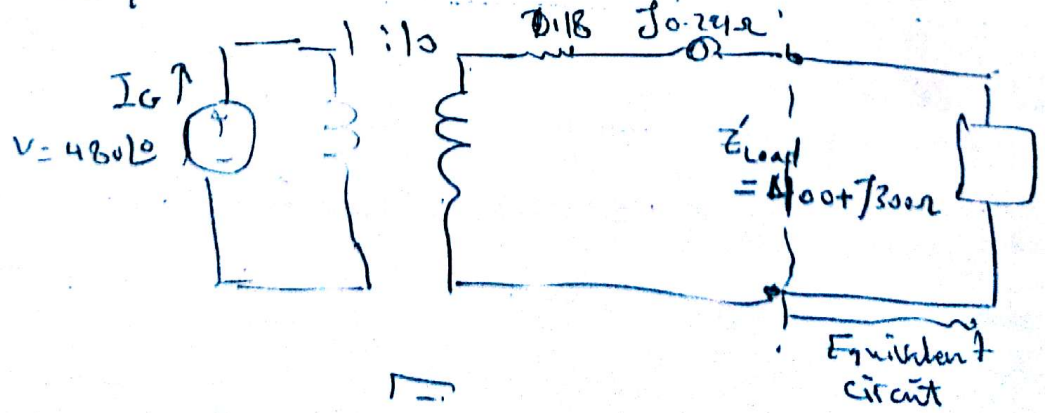
$$Z_{Load} = a^2 Z_{Load}$$

$$= \left(\frac{10}{1}\right)^2 (4+j3) = 400+j300 \Omega$$

The total impedance at the transmission line level is now

$$Z_{eq} = Z_{line} + Z_{load}$$

$$Z_{eq} = 400.18 + j300.24 \Omega = 500.3 \angle 32.98° \Omega$$



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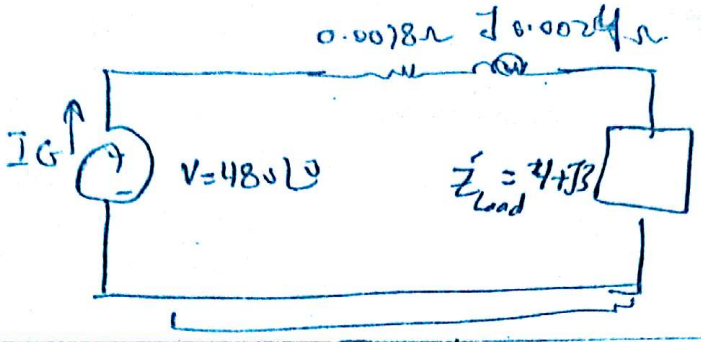

Equivalent circuit

$$Z'_{eq} = a^2 Z_{eq} = a^2 (Z_{line} + Z'_{Load})$$

$$= \left(\frac{1}{10}\right)^2 (0.18\Omega + j0.24\Omega + 4\Omega + j3\Omega)$$

$$Z'_{eq} = (0.0018\Omega + j0.0024\Omega + 4 + j3) = 5.003\angle 36.88\ \Omega.$$

$Z'_{Load} = 4 + j3$, $Z'_{Line} = 0.0018 + j0.0024\ \Omega$.

The current $I_G = \dfrac{480\angle 0\ V}{5.003\angle 36.88^\circ\ \Omega} = 95.94\angle -36.88^\circ\ A.$

For $T_1 \Rightarrow$ Turns ration is $N_{P1} : N_{S1}$, T_2 turns ration is $N_{P2} : N_{S2}$

$$\frac{I_{line}}{I_G} = \frac{N_{P1}}{N_{S1}} \Rightarrow I_{line} = \frac{1}{10}(95.94\angle -36.88) = 9.594\angle -36.88$$

$$I_{Load} = \frac{N_{P2}}{N_{S2}} I_{Line} = \frac{10}{1}(9.594\angle -36.88^\circ) = 95.94\angle -36.88^\circ\ A$$

$$\therefore V_{Load} = I_{Load}\, Z_{Load} = (95.94\angle -36.88)(5\angle 36.87) = 475.7\angle -0.01\ Volt$$

$$P_{losses} = I_{line}^2 R_{line} = (9.594)^2 (0.18) = 16.7\ watt.$$

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(11) A 10KVA, 1phase, 50Hz, 500/250 Volt transformer gave following test results:.

OC test (LV) side: 250V, 3A, 200watt

SC test (HV) side 15V, 30A, 300W.

Calculate efficiency and regulation at full load 0.8 pf lagging.

∵ F.L current = $\frac{10,000}{250}$ = 40A.

Short circuit test data have been given at 30A on the l.v side.

i^2r losses at 40A. L.V side = $\left(\frac{40}{30}\right)^2 \times 300$ watt = 533.3 watt.

At rated Voltage iron losses = 200watt.

FL output at 0.8PF = 10000×0.8 = 8000watts.

$\eta\% = \frac{8000}{8000 + 533.3} \times 100 = 91.6\%$

For regulation From S.C test we have found Z, Req

$Z = \frac{15}{30} = 0.5\Omega$, $Req = \frac{300}{30 \times 30}$, 0.333Ω

$X_{eq} = \sqrt{Z^2 - Req^2} = \sqrt{(0.5)^2 - (0.333)^2} = 0.373\Omega$.

Regulation

$: V_R = \frac{4.0}{250}\left[0.333 \times 0.8 - 0.373 \times 0.6\right] = 6.82 \times 10^{-3}$ p.u

$\therefore V_{Regulation} = 6.82 \times 10^{-3} \times 250 = 1.7$ Volt

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